ANALYSIS OF FUNCTIONAL OUTCOME FOR UNSTABLE DISTAL RADIUS FRACTURES TREATED WITH CLOSED REDUCTION AND PERCUTANEOUS 'K' WIRE FIXATION WITH CASTING AND CLOSED REDUCTION WITH CASTING : A COMPARATIVE STUDY

Dissertation submitted in partial fulfillment
of the regulations for the award of the degree of

MASTER OF SURGERY
BRANCH - II ORTHOPAEDIC SURGERY

Department of Orthopaedic Surgery,
GOVT. STANLEY MEDICAL COLLEGE &HOSPITAL
CHENNAI – 600 001

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY, CHENNAI

APRIL 2014

CERTIFICATE

This is to certify that **Dr. SURYAWANSHI VIKRAM VILAS**, post graduate student (2011 - 2014) in the Department of Orthopaedics and Traumatology, Govt. Stanley Medical College, Chennai has done this dissertation on **' ANALYSIS OF FUNCTIONAL OUTCOME FOR UNSTABLE DISTAL RADIUS FRACTURES TREATED WITH CLOSED REDUCTION AND PERCUTANEOUS 'K' WIRE FIXATION WITH CASTING AND CLOSED REDUCTION WITH CASTING : A COMPARATIVE STUDY '** under my guidance and supervision in partial fulfillment of the regulation laid down by the Tamil Nadu Dr. M.G.R Medical University, Chennai for MS (Orthopaedics) degree examination to be held on April 2014.

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Above all it is the blessings of The Almighty that made this study a successful one and to Him I offer my sincere prayers.

I dedicate this work to my loving Mother & Father who have been eternal inspiration for my achievements.

DECLARATION

I, **DR. SURYAWANSHI VIKRAM VILAS,** solemnly declare that this dissertation entitled

'ANALYSIS OF FUNCTIONAL OUTCOME FOR UNSTABLE DISTAL RADIUS FRACTURES TREATED WITH CLOSED REDUCTION AND PERCUTANEOUS 'K' WIRE FIXATION WITH CASTING AND CLOSED REDUCTION WITH CASTING : A COMPARATIVE STUDY '

Is a bonafide work done by me at Government Stanley Medical College, Chennai between 2012-2014 under the guidance and supervision of our respected Head of The Department

Prof. Dr. ARUNMOZHIMARAN VIJAYABABU M.S.Ortho., D.Ortho.

This dissertation is submitted to **THE TAMIL NADU DR.M.G.R MEDIAL UNIVERSITY, CHENNAI**, towards partial fulfillment of regulations for the award of M.S Degree Branch II in Orthopaedic surgery.

Place : CHENNAI DR. SURYAWANSHI VIKRAM VILAS

Date:

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ABSTRACT

Background : Fractures of the distal radius are among the most common fractures and closed in most of the cases, has long been treated by closed reduction with casting . Although cast does provide support, it may fail to maintain the reduction. Percutaneous 'K' Wire fixation is a simple way of providing additional stability to immobilization in cast in an unstable fracture of distal radius in which anatomical reduction is obtainable.

Objective : The purpose of present study was to compare two treatment methodologies (1) Closed reduction along with percutaneous K wire fixation with casting (2) Closed reduction and casting alone for the treatment of displaced unstable extra-articular and simple intra-articular fractures of distal part of radius, with specific emphasis on functional and radiological outcome.

Materials and Methods : A prospective randomised study was performed at Govt. Stanley Medical College and Hospital, Chennai. Forty patients with displaced , unstable fractures of distal radius were randomised in two treatment groups Closed reduction along with percutaneous K wire fixation with casting (n=20) or Closed reduction and casting alone (n=20). Functional and radiological assessments were done at six, nine, twelve weeks post-intervention. Outcome was measured on the basis of range of motion, grip strength, Disability of Arm, Shoulder and Hand (DASH) Scoring, radiological parameters. Detailed analysis of complications was performed.

Results : On functional analysis based upon Disability of Arm, Shoulder and Hand (DASH) scoring system the K wire fixation and casting group had lower mean scores compared with closed reduction and casting group both at nine (16.59 compared with 18.41 with p value 0.593) and at twelve weeks (17.24 compared with 17.76 with p value 0.877) indicating no significant difference in terms of functional outcome; though lower scores indicates better outcome considered on individual basis. At end of twelfth week post-intervention thirteen patients (76.87%) of K wire and casting group resumed to their regular work as compared to ten (58.82%) patients of closed reduction and casting group. On radiological assessment both group of patients had significant improvement in radiological criteria viz; Radial Length, Volar tilt, Radial Inclination and Ulnar variance post-intervention (with p values for each of parameters <0.005). Also there was no significant changes in all these parameters between ninth and twelfth weeks post-intervention in both of these groups; although changes in K wire and casting group were lower as compared with closed reduction and casting group. In K wire and casting group two patients (10%) developed pin site infection. Finger stiffness was major problem in either group. In K wire and casting group seven patients (35%) had finger stiffness compared with nine (45%) patients in closed reduction and cast immobilisation group.

Conclusions : In unstable distal radius fractures both the techniques of managements K wire fixation and casting and closed reduction and casting gives near equal results in terms of functional outcome. Better anatomical reduction and maintenance of reduction can be expected with K wire fixation and casting group.

Keywords : Distal radius, Unstable, Comminuted fracture, percutaneous, closed reduction

INTRODUCTION

Fractures of the distal radius are among the most common fractures encountered in orthopaedic emergency practice. Almost two centuries before Sir Abraham Colles described a fracture distal radius in 1814. Still there is no consensus regarding the description , assessment and management of the outcomes of fracture distal radius.

Distal radius fracture being the most common fracture and closed in most of the cases, has long been treated by closed reduction with casting . Although cast does provide support, it may fail to maintain the reduction. Hence, in a majority of cases, with cast in situ satisfactory reduction will redisplace or reangle resulting in a poor anatomical and functional outcome.

Several factors have been associated with redisplacement after closed manipulation of a distal radius fracture.

- The initial displacement of the fracture. The greater the degree of the initial displacement is (especially radial shortening), the more energy was

imparted to the fracture, resulting in a higher likelihood that closed treatment will be unsuccessful.

- The age of the patient. Fractures in elderly patients with osteopenic bones tend to displace particularly late.
- The extent of metaphyseal comminution (the metaphyseal defect)
- Finally, displacement after closed treatment is a predictor of instability, and repeat manipulation is unlikely to result in a successful radiographic outcome.

Distal radius fractures with displacement are considered unstable when alignment cannot be maintained after closed reduction in a forearm plaster. Prior attempts have been made by different studies to identify the risk factors for the instability from which we can predict instability at initial presentation. To prevent or minimize the loss of reduction of unstable distal radius fractures various methods has been devised and includes

1) Percutaneous 'K' Wire fixation
2) External fixator
3) External fixator with augmentation with pins
4) Open reduction with internal fixation with or without bone grafting

Percutaneous 'K' Wire fixation is a simple way of providing additional stability to immobilization in cast in an unstable fracture of

distal radius in which anatomical reduction is obtainable . The technique is simple, minimally invasive and inexpensive. It is simple to use and much less intrusive than other methods such as external fixation. Though it have its own complications e.g. pin tract infection, superficial radial neuropathy etc.

AIM

The aim of this study is to analyze and compare functional and anatomical outcome of management of unstable distal radius fracture treated by closed reduction and cast immobilization with closed reduction and percutaneous 'K' Wire fixation along with casting .

REVIEW OF LITERATURE

HISTORY

Sir Abraham Colles, in the year 1814, a surgeon from Ireland described the most common fracture pattern affecting the distal radius and that even before the invention of X rays. Ponteau, a French surgeon is said to have described the same fracture earlier in 1783.

Hutchinson described radial styloid fracture, after the introduction of radiography and named it as Chauffeur's fracture. In the nineteenth century two more surgeons notably Barton and Smith also described fractures of distal radius.

These eponyms were important at one time; however, current diagnosis and treatment involve understanding the physiology and biomechanics of the fracture.

Initially distal radius fractures were treated with splints and plaster of paris casts.

In 1944, Anderson and O'Neil described external fixator for management of distal radius fractures.

Lindstrom in 1959, his study on the end results of fractures of distal distal radius, published in Journal Of Acta Orthopaedica Scandinavia.

Frykman, introduced his classification in 1967.

Skeletal transfixation with casting as an alternative method described by Cole and Obletz.

Volar buttress plate, introduced by Ellis in 1965.

Diego L. Fernandez a Swiss orthopaedician in 1985 , introduced mechanism based classification for distal radius fractures.

In 1996 Hudak et al published their approachto evaluation of disability of upper limb disorders : the DASH (Disability of Arm, Shoulder and Hand) score.

EPIDEMIOLOGY

Incidence

Distal radius fractures are among the most common fractures of upper extremity. Fracture of distal radius represent approximately one-sixth of all fractures treated in emergency department.

Age

The incidence of this injury appears to be both gender and age specific. There are three main peaks of fracture distribution: the first peak is in children ages 5 to 14, the second is in males under age 50, and the third peak is in females over the age of 40 years.

Sex

Most of these fractures occur in post-menopausal women. So in elder age group , male to female ratio is 1:4. Contrary to this in adolescent group boys to girl ratio is 3:1 . These fractures represent two very different injuries: one, an insufficiency fracture in elderly

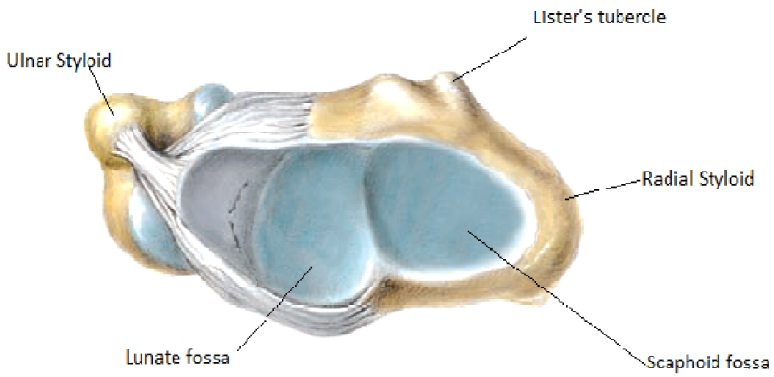
patients resulting from trivial trauma; associated with all of the risk factors for osteoporosis, and the other is a traumatic injury in younger males may be high energy trauma.

Risk Factors

Osteoporosis, female gender, early menopause are the major risk factors.

ANATOMY

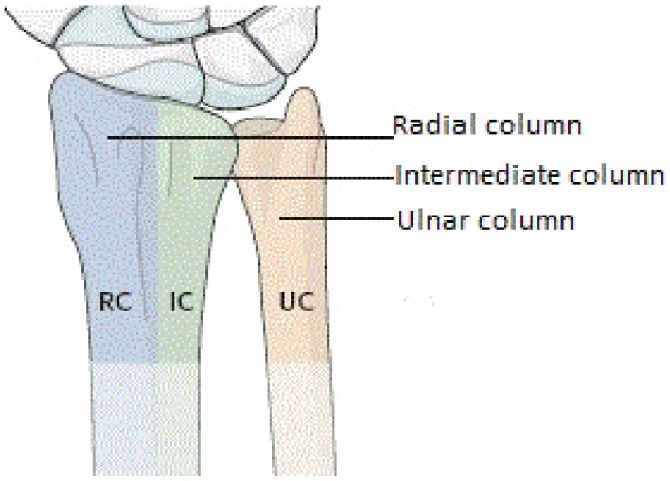
The distal radius consists of the (a) metaphysis, (b) scaphoid fossa, (c) lunate fossa, and (d) sigmoid notch. The metaphysis is flared distally in both the antero-posterior and the lateral planes with thinner cortical bone lying dorsally and radially . Scaphoid fossa, lunate fossa and sigmoid notch articulates with scaphoid, lunate and ulnar head respectively.



Distal Radius And Articulations

The distal radius and hand as a single unit articulate and rotate about head of ulna via sigmoid notch of the radius.

Rikkli et al interpreted the wrist as consisting of three distinct columns, each of which is subjected to different forces and must be addressed as discrete elements.



Three Columns Of Wrist

The radial column consists of the scaphoid fossa and the radial styloid. Impaction of the scaphoid on the articular surface results in a shear moment on the radial styloid causing failure laterally at the radial cortex.

The intermediate column consists of the lunate fossa and the sigmoid notch of the radius. The intermediate column may be considered the

cornerstone of the radius because it is critical for both articular congruity and distal radioulnar function. Failure of the intermediate column occurs as a result of impaction of the lunate on the articular surface with dorsal comminution. A direct buttress of the dorsal ulnar aspect of the radius stabilizes the column. Collapse of the lunate facet results in radiocarpal incongruity, and collapse of the radial metaphysis results in radioulnar incongruity.

The ulnar column consists of the ulna styloid, but also should include the TFCC (Triangular Fibro Cartilage Complex) and the ulnocarpal ligaments.

80% of axial load is supported by the distal radius and 20% by the ulna and the triangular fibrocartilage complex (TFCC).

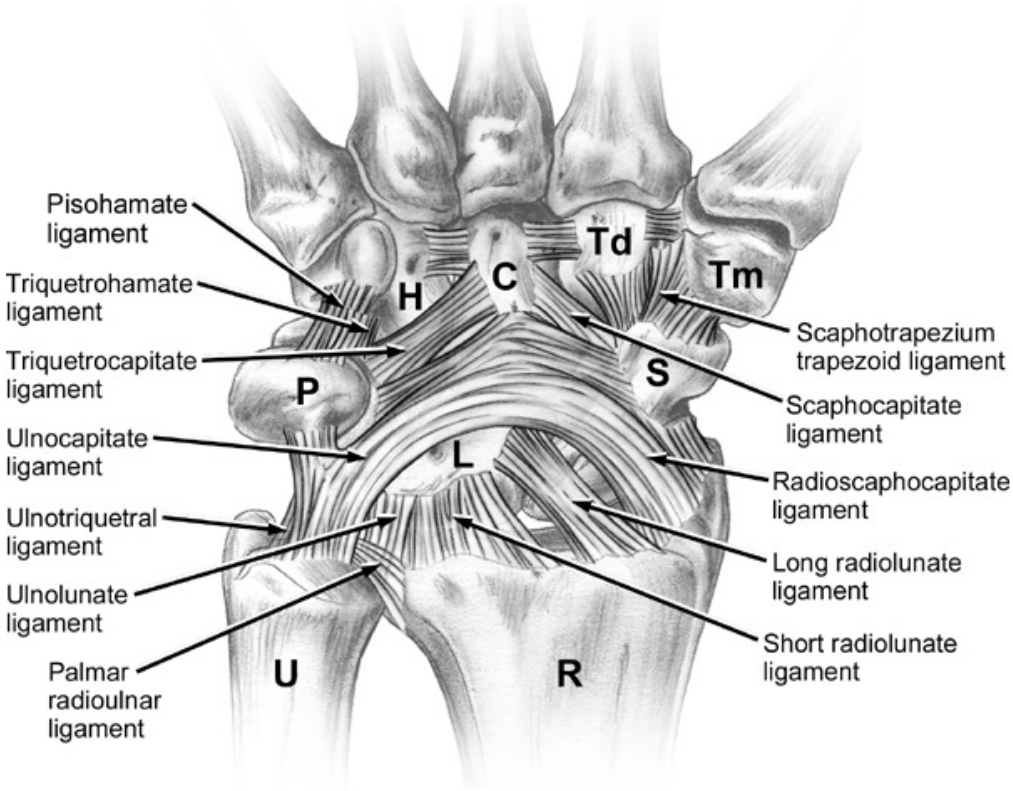
LIGAMENTS

The distal radius articulation with carpal bones and ulnar head is augmented by number of ligaments which play vital role in stability, load transfer and wrist kinematics.

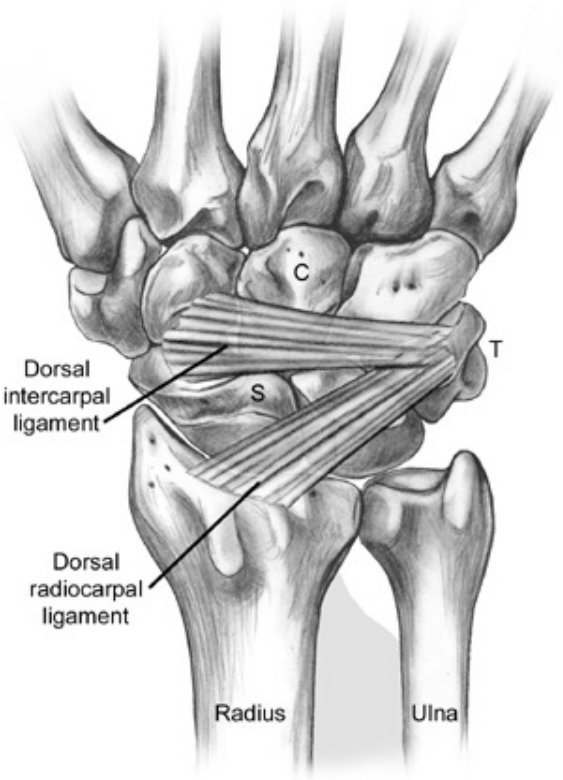
The extrinsic ligaments of the wrist play a major role in the use of indirect reduction techniques. The palmar extrinsic ligaments are attached to the distal radius, and these ligaments are relied on to reduce the components of a fracture using closed methods. There are two factors about these ligaments that make them significant for reduction. First, the orientation of the extrinsic ligaments from the radial styloid is oblique relative to the more vertical orientation of the ligaments attached to the lunate facet.

The second significance of the ligamentous anatomy is due to the relative strengths of the thicker palmar ligaments when compared with the thinner dorsal ligaments. In addition, the dorsal ligaments are oriented in a relative 'Z' orientation, which allows them to lengthen with less force than the more vertically oriented palmar ligaments. The significance is that distraction will result in the palmar ligaments becoming taut before the dorsal ligaments. Thus, the palmar cortex is brought out to length before the dorsal cortex. It is

for this reason that it is difficult to achieve reduction of the normal degrees of palmar tilt using distraction alone.



Palmar Ligaments



Dorsal Ligaments

EXTRINSIC LIGAMENTS

They connect forearm bones and carpal bones

Palmar Radio Carpal ligaments:

1)Radio Scapho Capitate ligament

- radial component of arcuate complex

2) Long Radio Lunate ligament

3) Short Radio Lunate ligament

4) Radio Scapho Lunate ligament

Dorsal Radio Carpal ligaments:

1) Radio Scaphoid ligament

2) Radio Triquetral ligament

3) Dorsal Intercarpal ligament

Ulno Carpal ligaments:

1) Ulno Capitate ligament

- ulnar component of cruciate ligament

2) Ulno Triquetral ligament

3) Ulno Lunate ligament

Distal Radio Ulnar ligaments:

1) Triangular Fibro Cartilage Complex

It is the most important stabilizer of Distal Radio Ulnar Joint. It arises along the entire ulnar aspect of the distal articular surface of the radius, at the distal margin of the sigmoid notch. It is inserted into base of ulnar styloid, lunate, triquetrum, hamate and finally at the base of fifth metacarpal.

The central 80% of Triangular Fibro Cartilage Complex is avascular.

2) Dorsal and Volar Radio-Ulnar ligaments.

INTRINSIC LIGAMENTS

They interconnect carpal bones. Important are Scapho Lunate interosseous ligament and Luno Triquetral interosseous ligament.

KINEMATICS

The muscles of the wrist are attached to the metacarpals. Capitate act as the centre of rotation for wrist joint.

Wrist flexion and extension occur equally through radio carpal and midcarpal joints.

Radial and ulnar deviations occur 60% through Mid-carpal joint and remaining through radio carpal joint.

Normal range of movements:

i. Flexion 0 to 70-90º
ii. Extension 0 to 70-90º

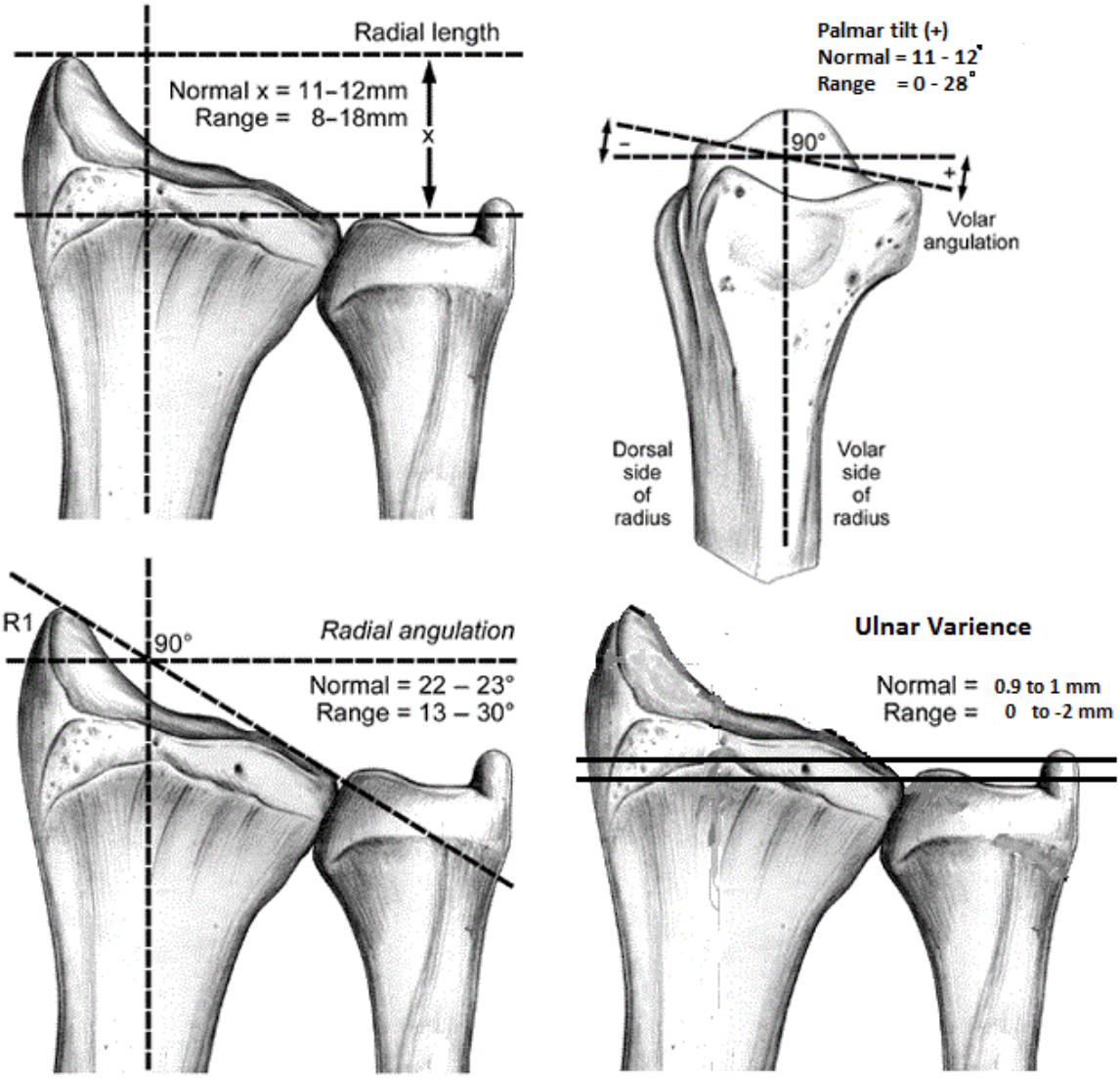
iii. Supination 0 to 70-90º

iv. Pronation 0 to 70-90º

v. Radial deviation 0 to 15-25º

vi. Ulnar deviation 0 to 25-35º

RADIOGRAPHIC PARAMETERS



Radial Height or Length

It is distance between tip of radial styloid and articular surface of ulna along longitudinal radial axis in postero-anterior view. Normal length is 11-12mm.

Radial Inclination

Angle between longitudinal radial axis and a line touching tip of radial styloid and radial articular surface, measured in postero-anterior view. Normal angle is 22-23˚.

Palmar Tilt

Measured in laterl view it's angle between plane perpendicular to longitudinal radial axis and plane of distal articular surface. Normal angle is 11-12˚.

Ulnar Variance

It's difference between radial and ulnar articular sufaces with carpals. It's measured in postero-anterior view. It may be positive, negative or neutral. Positive value indicates loss of radial height. Normal value is 0.9 to 1mm.

In a suspected case of distal radius fracture standard postero-anterior and lateral views of x-ray are taken.

In the postero-anterior view x-ray following parameters are given importance

- Loss of radial height
- Radial inclination
- Ulnar variance
- Intra-articular step-off
- Fracture comminution
- Associated ulnar styloid fracture
- Distal radio-ulnar joint injury

Following parameters attended in lateral view of x-ray

- Palmar tilt
- Metaphyseal comminution
- Volar cortex displacement

An oblique view may be obtained to assess the extent of comminution.

Contra lateral wrist postero-anterior and lateral view x-ray are taken to assess the patients normal radiological parameters.

Restoration of normal anatomy is crucial for restoration of function. Normally 82% of the compressive load at wrist joint is borne by distal radius

and remaining by distal ulna. 2.5 mm loss in radial length results in 42% load on ulna and with 20 degree of dorsal angulation, ulna bears 50% of load.

Restoration of radial length is the most important factor for preservation of function. Loss of radial length can lead to ulnar impaction or dysfunction of DRUJ, with limited range of motion in pronation and supination, depending on the volar or dorsal subluxation of the ulnar head within the sigmoid notch.

Residual dorsal angulation can precipitate ulnar impaction, midcarpal instability and altered stress concentration which may lead to early arthritis. Porter, in his study, felt that loss of function did not occur until at least 20 degrees of palmar tilt was lost.

In both treatment methods radial length, ulnar varience, radial angulation are restored to near normal but correction of dorsal tilt is not complete. This is because the fact that volar ligaments are stronger on distraction before relatively ‘Z’ oriented dorsal ligaments. So, on distraction volar cortex is brought out to length before dorsal cortex preventing full correction of dorsal tilt.

MECHANISM OF INJURY

A fall on the outstretched hand is the most common mechanism leading to distal radius fracture. The fracture pattern determined by the following variables

1) Velocity
2) Position of hand and wrist at impact
3) Degree of rotation of forearm
4) The individual's bone quality and density

In a forward fall in which the forearm is pronated and the hand and wrist extended, the body weight of the patient is transmitted along the axis of radius resulting in *bending* forces at the level of metaphyseal bone. The volar cortex fails under *tensile* stress and the dorsal cortex fails from *compressive* forces at impact.

Impaction and collapse of the cancellous bone of the metaphysis also occur due to penetration of the harder and stiffer cortical bone at the proximal diaphyseal section. With dorsally displaced fractures, the distal fragment supinates with respect to the radial diaphysis.

Ulnar styloid fractures have been identified in approximately half of distal radius fractures. The Triangular Fibro Cartilage can be injured with or without an associated fracture of ulnar styloid.

CLASSIFICATION

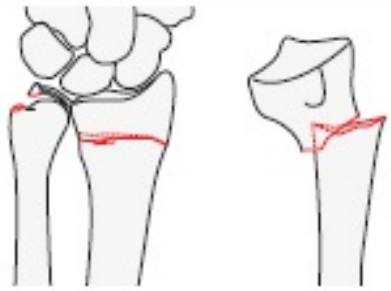
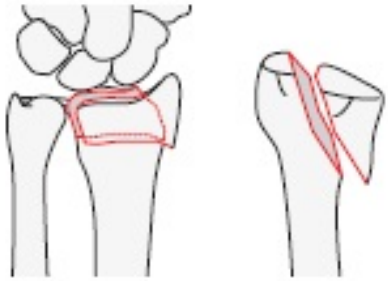
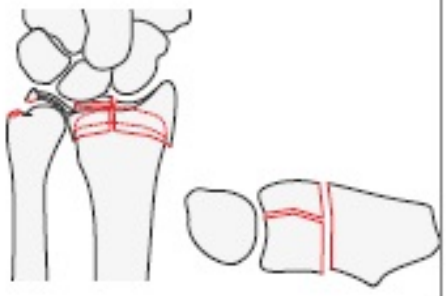
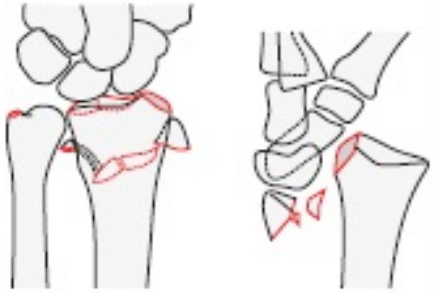
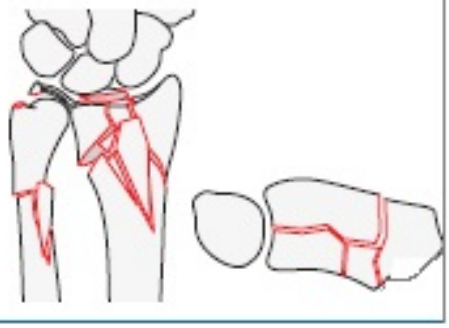
The classification systems available the for distal radius fractures are

I. Fernandez and Geissler classification
II. A.O. classification
III. Frykman classification
IV. Gartland and Werely classification
V. Melone classification
VI. Rayhack universal classification
VII. Mayo clinic classification
VIII. Lindstrom classification
IX. Thomas classification
X. Older et al classification
XI. McMurty classification

Fernandez and Geissler Classification

Fernandez proposed a mechanism-based classification system that would address the potential for ligamentous injury and thereby assist in treatment recommendations :

- **Type I:** Metaphyseal ***bending*** fractures with the inherent problems of loss of palmar tilt and radial shortening relative to the ulna (DRUJ injuries).
- **Type II:** ***Shearing*** fractures requiring reduction and often buttressing of the articular segment.
- **Type III:** ***Compression of the articular surface*** without the characteristic fragmentation; also includes the potential for significant interosseous ligament injury.
- **Type IV:** ***Avulsion*** fractures or radio-carpal fracture dislocations.
- **Type V:** ***Combined*** injuries with significant soft tissue involvement due to the high-energy nature of these fractures.

Type I Bending fracture of the metaphysis	
Type II Shearing fracture of the joint surface	
Type III Compression fracture of the joint surface	
Type IV Avulsion fractures, radiocarpal fracture, dislocation	
Type V Combined fractures (I, II, III, IV); high-velocity injury	

FERNANDEZ CLASSIFICATION OF DISTAL RADIUS FRACTURE

This systems also addresses DRUJ instabilty

Type I : Stable following reduction and DRUJ is congruent and stable

A) Avulsion fracture of styloid tip

B) Stable ulnar neck fracture

Type II : Unstable , following reduction subluxation or dislocation of ulnar head occurs

A)Substance tear of TFCC and/or palmar and dorsal capsular ligaments

B) Avulsion fracture base of ulnar styloid

Type III : Potentially unstable, subluxation is possible

A) Intraarticular # of sigmoid notch

B) Intra articular fracture of ulnar head

A.O. (Arbeitsgemeinschaft für Osteosynthesefragen) Classification

The A.O. classification system emphasizes over

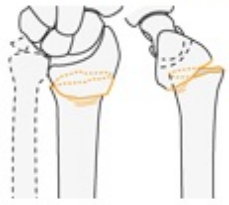
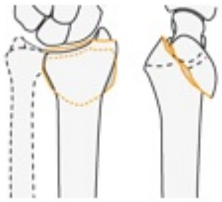
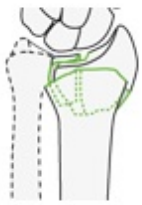
i. The increasing severity of the bony injury

ii. The displacement of the distal fragment

iii. Extent of articular involvement

iv. Associated distal ulna fracture

A.O. CLASSIFICATION OF DISTAL RADIUS FRACTURE

23-A Extra-articular 	**23-A1 Ulna fracture Radius intact** 	**23-A2 Rdius, simple and impacted** 	**23-A3 Comminuted radius metaphyseal fracture** 
23-B Partial articular 	**23-B1 Sagittal in radius styloid** 	**23-B2 Frontal in dorsal rim** 	**23-B3 Frontal in volar rim** 
23-C Complete articular 	**23-C1 Simple metaphyseal & simple articular** 	**23-C2 Comminuted metaphyseal & simple articular** 	**23-C3 Multifragmented** 

This classification system have three main categories .

Each of them further devided in subclasses

A. Extra-articular

B. Partial articular

C. Intra-articular

Type A – Extra articular fracture.

A1 – Extra articular ulnar fracture

A1.1 – Styloid process fracture

A1.2 – Simple fracture of metaphysis

A1.3 – Multifragmentary metaphyseal fracture

A2 – Simple or impacted extra articular radius fracture.

A2.1 – Undisplaced

A2.2 – With dorsal tilting

A2.3 – With anterior tilting

A3 – Simple or impacted multi fragment extra articular fracture.

A3.1 – With axial impaction and shortening

A3.2 – With a wedge

A3.3 – Complex

Type B – Partially articular fracture.

B1- Sagittal rim fracture

B1.1 – Simple lateral

B1.2 – Multifragmentary lateral

B1.3 – Medial

B2 – Dorsal rim fracture.

B2.1 – Simple

B2.2 – With an additional lateral sagittal fracture.

B2.3 – With dorsal dislocation of the carpus.

B3 – Volar rim fracture.

B3.1 – Simple with a small fragment

B3.2 – Simple with a large fragment

B3.3 – Multi fragmentary

Type C – Intra articular fracture.

C1 – Simple articular, simple metaphyseal fracture

C1.1 – With a postero medial articular fragment

C1.2 – Articular fracture line in sagittal plane

C1.3 - Articular fracture line in frontal plane.

C2 – Simple articular, multi fragment metaphyseal fracture.

C2.1 - Articular fracture line in sagittal plane.

C2.2 - Articular fracture line in frontal plane.

C2.3 – Metaphyseal fracture extends into the diaphysis

C3 – Complete articular multi fragment metaphyseal fractures.

C3.1- Metaphyseal simple

C3.2 – Metaphyseal fracture also multi fragmentary

C3.3 – Multi fragmentary metaphyseal fracture extending into the diaphysis.

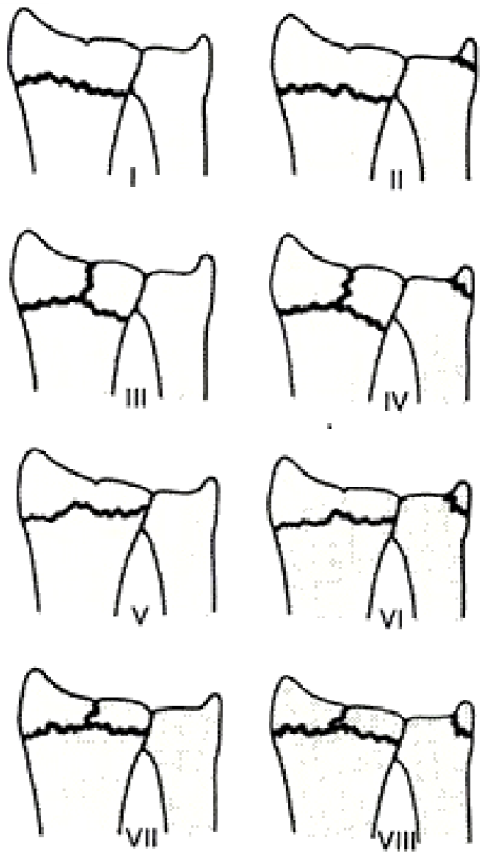
The complete AO classification for distal radius fracture have poor inter observer reliability and the main group classes are sufficient to be used reliably to grade the severity of the fracture.

Frykman classification

A classification that incorporated individual involvement of the radio-carpal and radio-ulnar joints along distal ulna fracture

FRYKMAN CLASSIFICATION OF COLLES' FRACTURE

Type	Fracture
I	Extra-articular radial fracture
II	Extra-articular radial fracture with an ulnar fracture
III	Intra-articular fracture of the radiocarpal joint without an ulnar fracture
IV	Intra-articular fracture of the radius with an ulnar fracture
V	Fracture of the radioulnar joint
VI	Fracture into the radioulnar joint with an ulnar fracture
VII	Intra-articular fracture involving radiocarpal and radioulnar joints
VIII	Intra-articular fracture involving radiocarpal and radioulnar joints with an ulnar fracture



FRYKMAN CLASSIFICATION OF COLLES' FRACTURE

Despite the plethora of classification systems, there continues to be perceived deficits in our ability to consistently and accurately classify these fractures in a manner that provides both prognosis and treatment guidance. It has also become increasingly apparent that outcome after these fractures may also depend on soft tissue injury, including inter-osseous ligament injury and DRUJ instability.

For an extra articular fracture, either one of the following features on initial presentation indicates ***instability***

1) Dorsal angulation of more than 20 degrees
2) Dorsal communication more than 50% of width
3) Radial shortening of more than 5mm
4) Volar Comminution
5) Translation more than 1 cm
6) Severe osteoporosis.

COMPLICATIONS

Complications of distal radius fractures range from 20 to 30% and are consequence of injury or of treatment. Complications may involve soft tissue (tendon, nerve, arterial or fascial complication, chronic regional pain syndrome) or bone and joint (malunion, nonunion, osteoarthritis). They may be categorised as

Immediate complications:

1) Compartment syndrome.
2) Skin injury during manipulation in the elderly.
3) Nerve injuries - commonly Median nerve.

4) Acute Carpal Tunnel Syndrome.

5) Open fractures

6) Missed associated injuries.

Early complications (less than 6 weeks):

1) Loss of reduction

2) Plaster related complications

3) Deep infections

4) Carpal Tunnel Syndrome.

5) Tendon rupture.

Late complications (more than 6 weeks):

1) Carpal Tunnel Syndrome.

2) Reflex Sympathetic Dystrophy

3) Malunion

4) Delayed union

5) Post traumatic arthritis

6) Tendon rupture and adhesions

Complications related to 'K' wire :

1) Pin site infection

2) Pin loosening

3) Radial sensory nerve injury

4) Tendonopathy

MATERIALS AND METHODS

This is a prospective randomised study conducted at Government Stanley Medical College and Hospital, Chennai from April 2012 to October 2013.

Patients between age group of 18 to 70 years with unstable distal radius fracture of A.O. type A2, A3, C1 were enrolled in this study.

Patient Inclusion Crieteria :

1. Age ≥18 years
2. Displaced extra-articular distal radius fractures
3. Simple intra-articular distal radius fractures
4. Closed distal radius fractures

Patient Exclusion Crieteria :

1. Patients who rely on others for basic activities
2. Complex articular fractures with more than one sagittal split
3. Open fractures

4. Fractures with neurovascular injuries
5. Associated with musculoskeletal injuries to ipsilateral upper limb

On first presentation of patient following things noted

1. Associated deformity
2. Skin condition
3. Neurovascular deficit
4. Movements of shoulder, elbow and fingers
5. Forearm rotatory movements

Preoperative Radiological Assessment

Standard postero-anterior and lateral view x-rays taken for affected and unaffected distal radii. Following parameters evaluated

1) Radial length
2) Radial inclination
3) Dorsal tilt

4) Ulnar variance

5) Metaphyseal comminution

6) Intra-articular step-off

Patients were divided in either group randomly. Operative procedures were carried out under brachial plexus block or general anaesthesia. Closed reduction procedures were carried out under hematoma block with subsequent check x-rays. After procedures all patients were applied below elbow plaster slab on dorsal forearm along with three point fixation.

Acceptable reduction criteria for distal radius fracture is

1) Radial shortening <5 mm at distal radio-ulnar joint
2) Radial inclination on postero-anterior radiographs >15˚
3) Sagittal tilt on lateral projection between 15˚ dorsal tilt and 20˚ volar tilt
4) Intra-articular step-off or gap <2 mm of radiocarpal joint
5) Articular incongruity <2 mm of sigmoid notch of distal radius

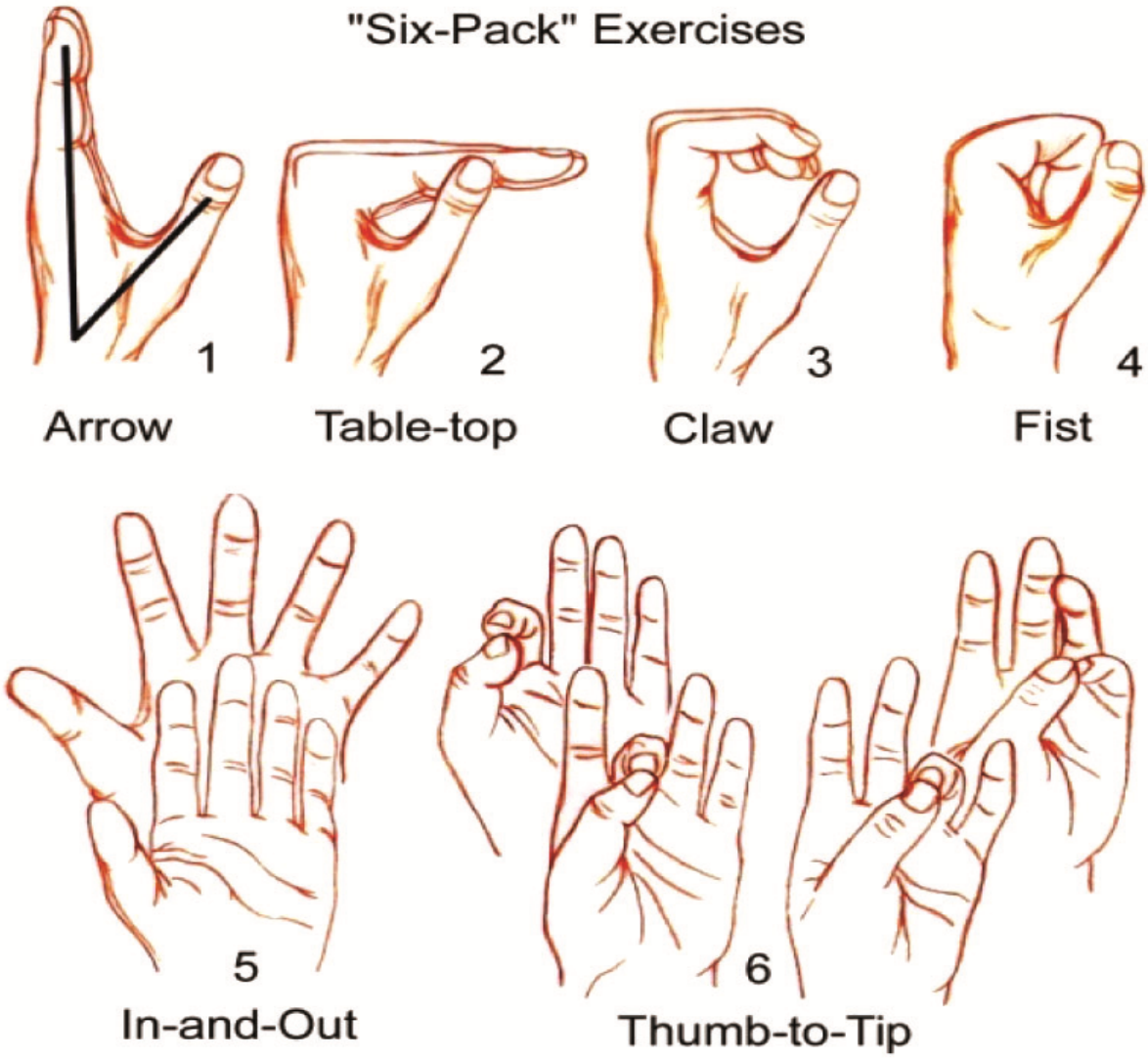
CLOSED REDUCTION WITH CAST IMMOBILSATION GROUP

Displaced fractures reduced by longitudinal traction and gentle manipulation. Traction is applied for disimpaction of the bone surfaces; holding the thumb, index finger, and middle finger. Counter-traction applied at arm with flexed elbow of patient by an assistant. Translation reduction manoeuvres are used. With maintained traction at the fracture site, flexion and ulnar deviation manoeuvres were applied to reduce the distal fragment. Finally the fracture was locked in reduced position by applying slight pronation, flexion and ulnar deviation forces.

With this maintained reduction below elbow plaster slab applied over dorso-radial aspect of forearm. Moulding of the splint using the three-point pressure technique is used to lessen the chances of re-displacement. Limb elevation given with cuff and collar as a sling.

Post reduction standard postero-anterior and lateral x-rays taken. If the reduction is inadequate but the fracture configuration is intrinsically stable, re-manipulation is performed. The patients were observed for 48hours to ensure that excessive swelling, neurovascular compromise to be avoided.

Active finger movements advised from day one. Once oedema subsides, slab was converted into cast usually around three to four days post-reduction. Wrist was brought to neutral position after evidence of fracture healing mostly around three to four weeks. Patients were encouraged for the *"six pack"* exercise regimen described by *Dobyns and Linscheid* at least three times a day along with elbow and shoulder mobilisation .



Patients were reviewed at 1st week, 3rd week, 6th week. At this stage fracture union was confirmed radiologicaly and cast removal done. Elasto-crepe bandage applied for couple of weeks hereafter.

Patients were encouraged for wrist movements. patients reviewed hereafter at a span of 3 weeks at 9th, 12th week respectively. At the end of 9th, 12th week functional and radiological outcome assessed.

PERCUTANEOUS K-WIRE FIXATION WITH CASTING GROUP

In K-wire fixation group, the affected limb painted and draped. The fracture reduction done with same manoeuvre as closed reduction group. Fracture reduction and fragments alignment were checked under C-arm. After satisfactory reduction percutaneous K-wire fixation done.

We used a technique using three K-wires. K wires of thickness 1.5 and 1.8 mm were used. Two are introduced from the tip of the radial styloid towards medial cortex of distal radius, one from the dorsoulnar aspect of dorsal distal radius in dorso-volar direction. First, a 5 mm incision is

made over the tip of the radial styloid. The radial styloid is exposed by blunt dissection and great care is taken not to injure the sensory branch of the radial nerve or the tendons of the first and third extensor compartments.

The K wire tip is introduced between the soft tissues. After checking reduction and anticipated direction of the K-wire using image intensification, the K-wire is introduced carefully with a power drill. The K-wire just penetrated the medial cortex of the radial shaft. A second K-wire is introduced through the radial styloid in the same manner, but in a divergent direction.

Third K-wire: Insertion from the dorsoulnar aspect. A second incision is made between the fourth and fifth extensor compartments. Blunt dissection to the bone is carried out. Under image intensifier control, the third K-wire is introduced from the dorsoulnar rim of the radius into the anterior cortex of the radial shaft**.**

The K-wires were cut and bent 180º to avoid further migration into the bone. To prevent skin penetration by bent K wire tips, small gauze piece soaked with betadine was applied at base of K wire entry point. The

forearm was splinted with dorsal below-elbow plaster slab, arm cuff and collar sling provided for forearm support.

Postoperatively limb elevation was given to prevent oedema development. Intravenous antibiotics were given for two days followed by oral antibiotics for three more days. Patients were encouraged for active finger movements with special emphasis on 'Six-Pack' exercise regime. Elbow and shoulder movements also taught.

Patients were discharged at 3-4 days post-op and reviewed after 1 week. At 1st visit any sign of pin site infection was noted. Plaster slab was replaced with circumferential cast. Patients were reviewed after this at 3rd week of postop.

At 3rd week any cast loosening noted, standard postero-anterior and lateral x-rays taken to assure K wire position and maintenance of fracture reduction. At 6th post-op week cast removal and K wire removal done after fracture union was confirmed radiologicaly . At the end of 6 weeks elasto-crepe bandage was applied for further 1 week.

At this stage active wrist exercise, forearm rotational exercises also taught. After this patients were reviewed at 9^{th} week and 12^{th} week. At each visit radiological and functional assessment done and compared with normal limb.

OBSERVATIONS AND RESULTS

Forty patients were enrolled in this study. Twenty patients treated with closed reduction and casting and twenty patients were treated with K wire fixation and casting. Among them seventeen were male and twenty three were female. The mean age for males was 51.8 years and 58.7 years for females. The dominant side was affected in 40% of K wire and casting group and 45% in cast immobilization group. Metaphyseal comminution was present in 57.5% patients.

Table 1. NUMBER OF PATIENTS

	K WIRE FIXATION AND CASTING	**CAST IMMOBILZATION**
MALE	**9**	**8**
FEMALE	**11**	**12**
SUM	**20**	**20**
TOTAL	**40**	

Table 2. AGE OF PATIENTS

AGE IN YEARS	K WIRE FIXATION AND CASTING - NUMBER OF PATIENTS		CAST IMMOBILIZATION – NUMBER OF PATIENTS	
	MALE	FEMALE	MALE	FEMALE
30 – 40	1	1	1	2
41 – 50	3	4	3	4
51- 60	4	5	3	6
61-70	1	1	1	0
MEAN	52.4	58.1	51.2	59.3

Table 3. SIDE OF INJURY

SIDE OF INJURY	K WIRE FIXATION AND CASTING (NO. OF PATIENTS)	CAST IMMOBILIZATION (NO. OF PATIENTS)
RIGHT	8	9
LEFT	12	11
%DOMINANT SIDE INJURY	40%	45%

Table 4. FRACTURE TYPE BY AO CLASSIFICATION

AO TYPE	K WIRE AND CASTING (NO. OF PATIENTS)	CAST IMMOBILIZATION (NO. OF PATIENTS AT)
A 2	6	8
A 3	12	11
C 1	2	1

The mechanism of injury by fall on outstretched hand was present in thirty five patients. Five patients sustained distal radius fracture in road traffic accidents.

All except two patients were treated on the same day of injury; two patient of K wire and casting group were treated on next day of injury.

In K wire and casting group two patients (10%) developed pin site infection. In one patient infection resolved with antibiotics without further sequelae. In other patient infection got deeper necessitating K wire removal at third week. Two patients (10%) of same group developed superficial radial nerve paraesthesia. Three patients (15%) of K wire and casting group

developed tendonopathy that resolved with physiotherapy on follow-up at ninth week.

Seven patients (35%) of this group had finger stiffness at six week follow-up that gradually resolved by twelve weeks in five patients and at end twelve weeks only two patients had finger stiffness of mild degree. Two patients (10 %) had shoulder stiffness unrelated to operative procedure that gradually resolved by nine weeks with shoulder mobilization exercises. No patient of this group developed median nerve neuropathy or other complications viz; compartment syndrome, carpel tunnel syndrome.

In closed reduction and casting group major complications were finger stiffness in nine patients (45%) and tendonopathy in four patients (20%). At end of twelve weeks finger stiffness resolved in six patients out of nine patients and rest of three patients had finger stiffness of mild to moderate degree at end of twelve weeks. Among four patients of tendonopathy two patients got complete relief by ninth week and rest of two patients had no complaints by twelfth week.

Similar to K wire and casting group two patients (10%) of closed reduction and casting group had shoulder stiffness that resolved by nine to ten weeks with shoulder mobilization and physiotherapy.

Loss of follow-up in K wire and casting group was three patients and remaining seventeen patients were followed up to twelve weeks. In closed reduction and casting group loss of follow-up was three patients and rest of seventeen patients were followed up to twelve weeks.

At follow-up patients were evaluated for pain, grip strength, range of movements, functional outcome, radiological outcome complications like pin site infection, loss of reduction, finger stiffness, median nerve related complications, carpel tunnel syndrome etc.

At end of each of sixth, ninth and twelfth weeks pain over the affected side evaluated and categorised as nil, mild, moderate and severe according to patient's response.

Table 5. PAIN

PAIN SEVERITY	K WIRE AND CASTING (NO. OF PATIENTS AT)			CAST IMMOBILIZATION (NO. OF PATIENTS AT)		
	SIX WEEKS	NINE WEEKS	TWELVE WEEKS	SIX WEEKS	NINE WEEKS	TWELVE WEEKS
NIL	5 (25%)	9 (52.94%)	13 (76.47%)	4 (20%)	5 (29.41%)	8 (47.06%)
MILD	9 (45%)	6 (35.30%)	4 (23.53%)	9 (45%)	7 (41.18%)	5 (29.41%)
MODERATE	6 (30%)	2 (11.76%)	-	7 (35%)	5 (29.41%)	4 (23.53%)
SEVERE	-	-	-	-	-	-

Table 6. GRIP STRENGTH

% OF OPPOSITE SIDE	K WIRE AND CASTING (NO. OF PATIENTS AT)			CAST IMMOBILIZATION (NO. OF PATIENTS AT)		
	SIX WEEKS	NINE WEEKS	TWELVE WEEKS	SIX WEEKS	NINE WEEKS	TWELVE WEEKS
76 - 100%	4 (20%)	8 (47.06%)	11 (64.71%)	2 (10%)	6 (35.29%)	9 (52.94%)
51 - 75 %	7 (35%)	6 (35.29%)	4 (23.53%)	9 (45%)	6 (35.29%)	6 (35.29%)
26 – 50 %	9 (45%)	3 (17.65%)	2 (11.76%)	9 (45%)	5 (29.42)	2 (11.77%)
0 – 25 %	-	-	-	-	-	-

Table 7. STIFFNESS

	K WIRE FIAXTION AND CASTING	CAST IMMOBILIZATION
6 WEEKS	7 (41.17%)	9 (52.94%)
12 WEEKS	2 (11.76%)	3 (17.64%)

The range of movements of palmar flxion, dorsi flexion, radial and ulnar deviation, supination and pronation were measured at end of 6th, 9th and 12th week and compared with opposite side.

Table 8. RANGE OF MOVEMENTS

PERCENTAGE OF OPPOSITE SIDE		K WIRE FIXATION AND CASTING (NO OF PATIENTS AT)			CAST IMMOBILIZATION (NO OF PATIENTS AT)		
		6 WEEKS	9 WEEKS	12 WEEKS	6 WEEKS	9 WEEKS	12 WEEKS
FLEXION	>60°	4 (20%)	8 (47.06%)	12 (70.59%)	4 (20%)	7 (41.18%)	10 (58.82%)
	41°-60°	14 (70%)	8 (47.06%)	5 (29.41)%	13 (65%)	9 (52.94%)	6 (35.29%)
	20°-40°	2 (10%)	1 (5.88%)	-	3 (15%)	1 (5.88%)	1 (5.88%)
EXTENSION	>60°	4 (20%)	9 (52.94%)	12 (70.59%)	4 (20%)	7 (41.17%)	11 (64.71%)
	41°-60°	13 (65%)	7 (41.18%)	5 (29.41%)	12 (60%)	8 (47.06%)	6 (35.29%)
	20°-40°	3 (15%)	1 (5.88%)	-	4 (20%)	2 (11.77%)	-
SUPINATION	>60°	2 (10%)	7 (41.18%)	10 (58.82%)	2 (10%)	6 (35.29%)	9 (52.94%)
	41°-60°	11 (55%)	6 (35.29)	5 (29.41%)	9 (45%)	6 (35.29%)	5 (29.41%)
	20°-40°	7 (35%)	4 (23.53%)	2 (11.77%)	9 (45%)	5 (29.41%)	3 (17.65%)
PRONATION	>60°	4 (20%)	9 (52.94%)	12 (70.59%)	3 (15%)	9 (52.94%)	11 (64.71%)
	41°-60°	13 (65%)	7 (41.18%)	4 (23.53%)	11 (55%)	6 (35.29%)	5 (29.41%)
	20°-40°	3 (15%)	1 (5.88%)	1 (5.88%)	6 (30%)	2 (11.77%)	1 (5.88%)
RADIAL DEVIATION	>15°	3 (15%)	6 (35.29%)	10 (58.82%)	4 (20%)	6 (35.29%)	11 (64.71%)
	11°-15°	13 (65%)	9 (52.94%)	5 (29.41%)	13 (65%)	10 (58.82%)	5 (29.41%)
	≤10°	4 (20%)	2 (11.77%)	2 (11.77%)	3 (15%)	1 (5.88%)	1 (5.88%)
ULNAR DEVIATION	>20°	4 (20%)	8 (47.06%)	13 (76.47%)	4 (20%)	8 (47.06%)	13 (76.47%)
	11°-20°	14 (70%)	8 (47.06%)	4 (23.53%)	13 (65%)	7 (41.17%)	4 (23.53%)
	≤10°	2 (10%)	1 (5.88%)	-	3 (15%)	2 (11.77%)	-

Table 9. FUNCTIONAL STATUS AT 12 WEEKS

Functional status was evaluated whether patient is able to adapt to his or her activities both household and occupational.

	K WIRE AND CASTING	CAST IMMOBILIZATION
REGULAR WORK	**13 (76.47%)**	**10 (58.82%)**
RESTRICTED WORK	**3 (17.65%)**	**5 (29.41%)**
UNABLE TO WORK	**1 (5.88 %)**	**2 (11.77%)**

In both groups both forearm with wrist x-rays taken and compared.

Table 10. K WIRE AND CASTING GROUP – RADIOLOGICAL ASSESMENT

Average measurements	Pre-operative (20 patients)	Post-operative (20 patients)	Nine weeks (17 patients)	Twelve weeks (17 patients)
RADIAL LENGTH (mm)	4.1	10.7	10.2	9.8
VOLAR TILT (˚)	-23.3	+8.85	+6.9	+5.78
RADIAL ANGULATION(˚)	11	19.15	18.02	17.44
ULNAR VARIANCE(mm)	+1.05	+0.4	+0.8	+1.02

Table 11. CAST IMMOBILIZATION – RADIOLOGICAL ASSESMENT

Average measurements	Pre-reduction (20 patients)	Post-reduction (20 patients)	Nine weeks (17 patients)	Twelve weeks (17 patients)
RADIAL LENGTH (mm)	3.7	9.4	8.27	7.43
VOLAR TILT (˚)	-23.45	2.45	-3.42	-4.67
RADIAL ANGULATION(˚)	9.70	20.7	18.56	16.21
ULNAR VARIANCE(mm)	+2.25	+1.1	+1.46	+1.93

Wilcoxon Signed Ranks Test applied to assess radiological outcome. Both the treatment methods showed significant outcome at the time of post-intervention. While comparing the radiological parameters at 9^{th} and 12^{th} weeks both groups have non-significant changes in radiological parameters.

Table 12. K WIRE AND CASTING GROUP – RADIOLOGICAL ASSESMENT

Parameters	Pre-operative (20 patients)	Post-operative (20 patients)	p-Value	Nine weeks (17 patients)	Twelve weeks (17 patients)	P-Value
RADIAL LENGTH (mm)	**4.1**	**10.7**	**0.000* <0.05**	**10.2**	**9.8**	**0.707**
VOLAR TILT (˚)	**-23.3**	**+8.85**	**0.000* <0.05**	**+6.9**	**+5.78**	**0.628**
RADIAL ANGULATION(˚)	**11**	**19.15**	**0.000* <0.05**	**18.02**	**17.44**	**0.250**
ULNAR VARIANCE (mm)	**+1.05**	**+0.4**	**0.101 >0.05**	**+0.8**	**+1.02**	**0.210**

- P-value - * Indicates Significant

(Wilcoxon Signed Ranks Test)

Table 13. CAST IMMOBILIZATION – RADIOLOGICAL ASSESMENT

Parameters	Pre-reduction (20 patients)	Post-reductin (20 patients)	p-Value	Nine weeks (17 patients)	Twelve weeks (17 patients)	p-value
RADIAL LENGTH (mm)	**3.7**	**9.4**	**0.000* <0.05**	**8.27**	**7.43**	**0.489**
VOLAR TILT (˚)	**-23.45**	**2.45**	**0.000* <0.050**	**-3.42**	**-4.67**	**0.404**
RADIAL ANGULATION(˚)	**9.70**	**20.7**	**0.000* <0.05**	**18.56**	**16.21**	**0.181**
ULNAR VARIANCE (mm)	**+2.25**	**+1.1**	**0.002* <0.05**	**+1.46**	**+1.93**	**0.125**

- p-value - * Indicates Significant

(Wilcoxon Signed Ranks Test)

Anatomical assessment was done according to Lindstrom and Frykman criteria. In K wire group five (29.41%) patients had grade I i.e. no deformity as compared to two (11.76%) patients in cast immobilization group. In K wire group majority patients i.e. ten (58.83%) had grade II outcome i.e. mild deformity. In cast immobilization group grade II (mild deformity) and grade III (moderate deformity) outcome was observed in equal number of patients i.e. six (35.29%). Grade IV outcome i.e. severe deformity was present in three (17.66%) patients of cast immobilization as compared to none of patient had severe deformity in K wire fixation group.

Table 14. ANATOMICAL OUTCOME (AT 12th WEEK) LINDSTROM AND FRYKMAN GRADING

	K WIRE FIXATION AND CASTING		CAST IMMOBILIZATION	
	Number Of Patients	Percentage	Number Of Patients	Percentage
GRADE I	5	29.41 %	2	11.76 %
GRADE II	10	58.83 %	6	35.29 %
GRADE III	2	11.76 %	6	35.29 %
GRADE IV	0	-----	3	17.66 %

The functional outcome was evaluated at end of nine and twelve weeks with Disability of Arm Shoulder and Hand (DASH) scoring. This system consists of thirty set of questionnaire for subjective evaluation including activities of daily living. By this system average scores were calculated and were 45.31 for K wire and casting group at nine weeks as compared to 46.67 for cast immobilization group. At end of twelve weeks scores were 22.74 and 23.40 respectively for K wire and casting and cast immobilization groups.

Table 15 . FUNCTIONAL ASSESSMENT
DISABILITY OF ARM, SHOULDER AND HAND (DASH) SCORING

AVERAGE DASH SCORE AT END OF	**K WIRE FIXATION AND CASTING** (17 patients)	**CAST IMMOBILIZATION** (17 patients)
9 WEEKS	**45.31**	**46.67**
12 WEEKS	**22.74**	**23.40**

***Higher scores indicates poorer outcome**

Mann-Whitney test was used for statistical evaluation of functional outcome. With this test mean DASH scores were compared in two groups at the end of nine and twelve weeks. At end of nine weeks p value was 0.593 (>0.005) and at end of twelve weeks p value was 0.877 (>0.005) indicating no significant difference between two groups in terms of functional outcome.

Table 16 . FUNCTIONAL ASSESSMENT

DISABILITY OF ARM, SHOULDER AND HAND (DASH) SCORING (Mann-Whitney Test applied)

MEAN DASH SCORE AT END OF	K WIRE FIXATION AND CASTING (Mean Rank) N=17	CAST IMMOBILIZATION (Mean Rank) N=17	p- Value
9 WEEKS	16.59	18.41	0.593
12 WEEKS	17.24	17.76	0.877

CASE ILLUSTRATIONS

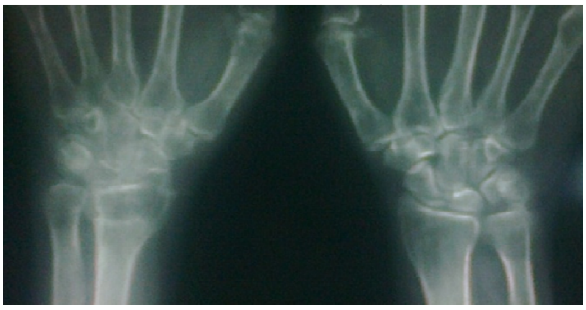
CASE 1 – K WIRE WITH CASTING

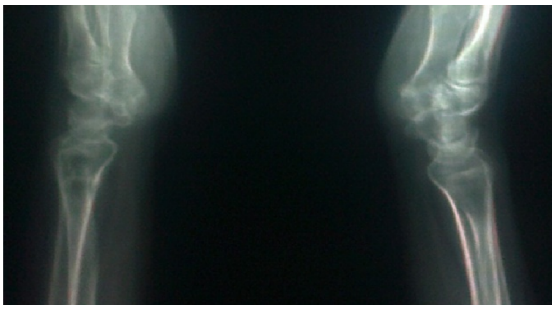
PREOPERATIVE


POSTOPERATIVE


9 WEEKS POST-OP


12 WEEKS POST-OP (Comparison with normal side)





RANGE OF MOVEMENTS

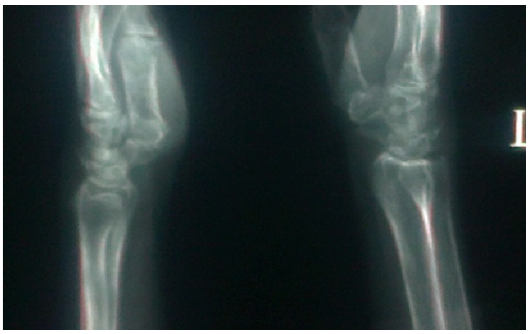
CASE 2 - K WIRE AND CASTING

PREOPERATIVE

POSTOPERATIVE

9 WEEKS POSTOP

12 WEEKS POSTOP (Comparison with normal side)

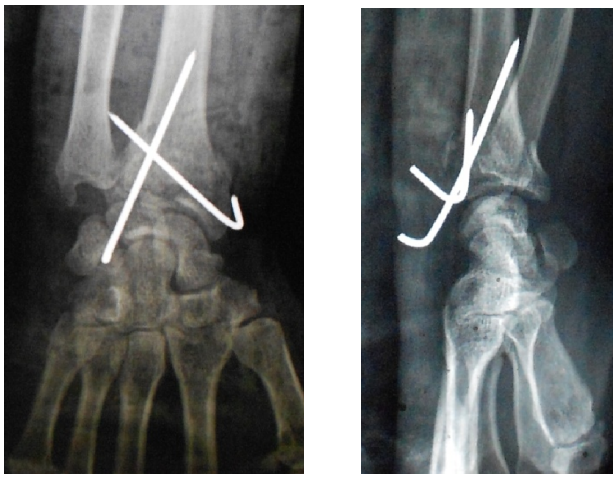


RANGE OF MOVEMENTS

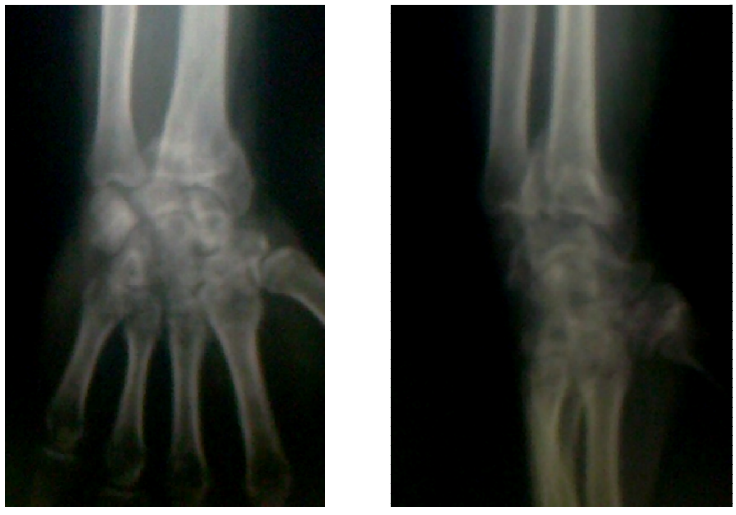
CASE 3 – K WIRE FIXATION AND CASTING

PREOPERATIVE

POSTOPERATIVE



9 WEEKS POST OP

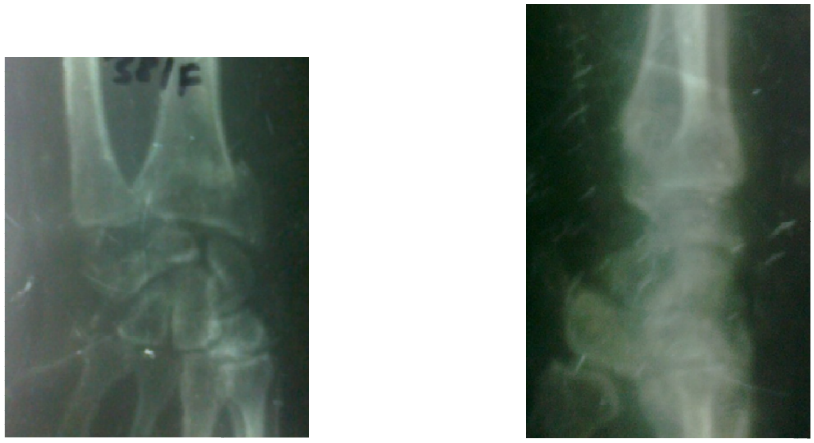


12 WEEKS POSTOP (Comparison with normal side)

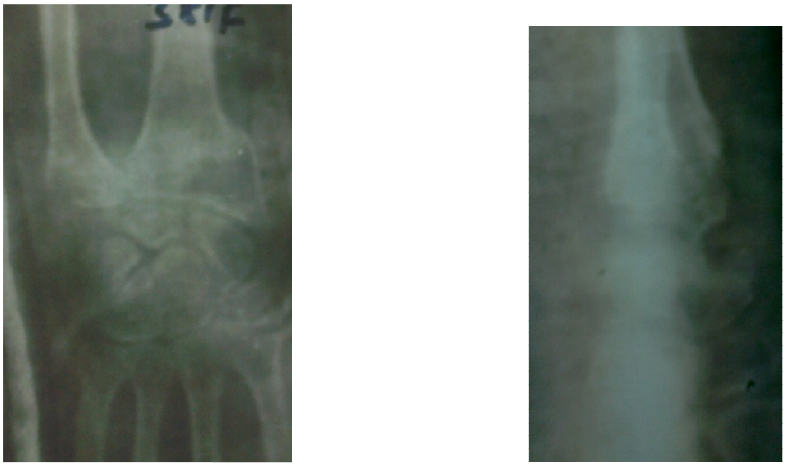
RANGE OF MOVEMENTS

CASE 1. CLOSED REDUCTION AND CASTING

PREREDUCTION

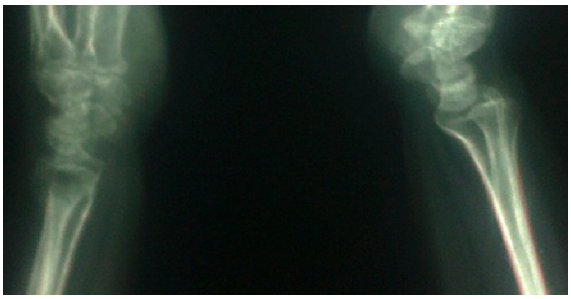


POSTREDUCTION



9 WEEKS POSTREDUCTION

12 WEEKS POSTREDUCTION (comparison with normal side)



RANGE OF MOVEMENTS

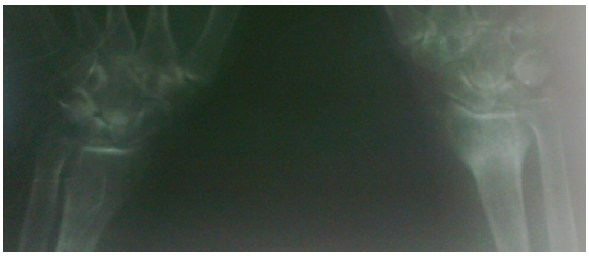
CASE 2 –CLOSED REDUCTION AND CASTING

PREREDUCTION

POSTREDUCITON

9 WEEKS POSTREDUCTION

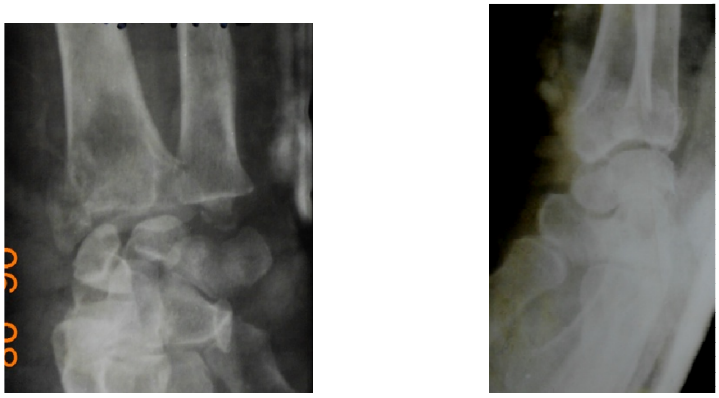
12 WEEKS POSTREDUCTION (comparison with normal side)



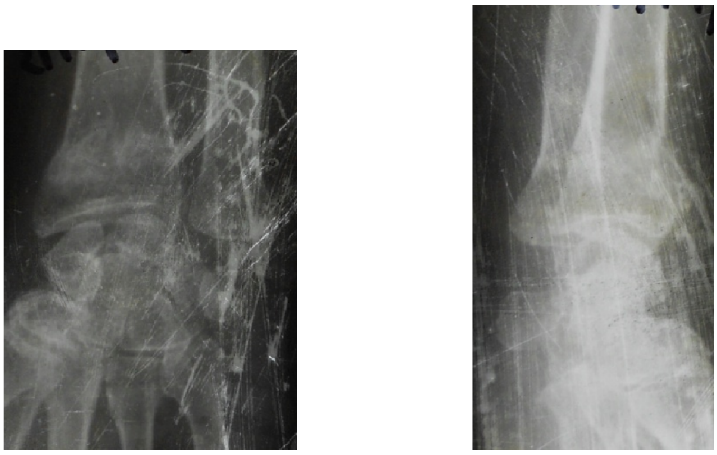
RANGE OF MOVEMENTS

CASE 3 – CLOSED REDUCTION WITH CASTING

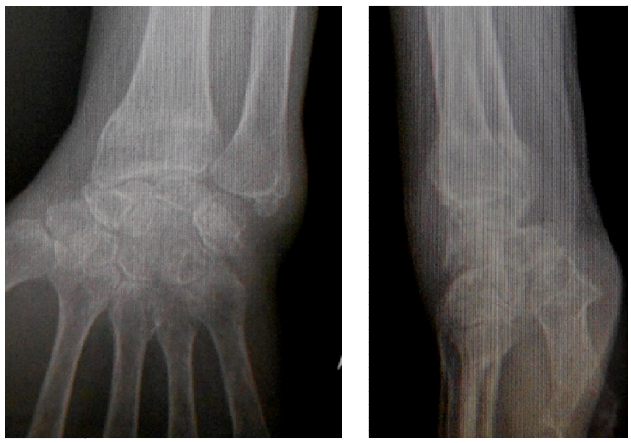
PREREDUCTION



POSTREDUCTION



9 WEEKS POSTREDUCTION



12 WEEKS POSTREDUCTION

RANGE OF MOVEMENTS

DISCUSSION

In this study, forty patients with unstable fractures of distal radius treated with K wire fixation and casting and closed reduction and casting were analysed in terms of functional and radiological outcome.

On functional analysis based upon Disability of Arm, Shoulder and Hand (DASH) scoring system the K wire fixation and casting group had lower mean scores compared with closed reduction and casting group both at nine (16.59 compared with 18.41 with p value 0.593) and at twelve weeks (17.24 compared with 17.76 with p value 0.877) indicating no significant difference in terms of functional outcome; though lower scores indicates better outcome considered on individual basis. At end of twelfth week post-intervention thirteen patients (76.87%) of K wire and casting group resumed to their regular work as compared to ten (58.82%) patients of closed reduction and casting group.

In our study, anatomical outcome was assessed on the basis of Lindstrom and Frykman grading system**.** In K wire and casting group five (29.41%) patients had grade I i.e. no deformity as compared to two (11.76%) patients in cast immobilization group. In K wire group majority patients i.e. ten (58.83%) had grade II outcome i.e. mild deformity. In cast immobilization

group grade II (mild deformity) and grade III (moderate deformity) outcome was observed in equal number of patients i.e. six (35.29%). Grade IV outcome i.e. severe deformity was present in three (17.66%) patients of cast immobilization as compared to none of patient had severe deformity in K wire fixation group.

On radiological assessment both group of patients had significant improvement in radiological criteria viz; Radial Length, Volar tilt, Radial Inclination and Ulnar variance post-intervention (with p values for each of parameters <0.005). Also there was no significant changes in all these parameters between ninth and twelfth weeks post-intervention in both of these groups; although changes in K wire and casting group were lower as compared with closed reduction and casting group

In K wire and casting group two patients (10%) developed pin site infection. In one patient infection resolved with antibiotics without further sequelae. In other patient infection got deeper necessitating K wire removal at third week.

Finger stiffness was major problem in either group. In K wire and casting group seven patients (35%) had finger stiffness compared with nine (45%) patients in closed reduction and cast immobilisation group.

Thus both types of intervention produced statistically similar results in terms of functional outcome according to DASH scoring system. Also the changes in radiological parameters were non-significant between ninth and twelfth weeks post-intervention in both groups of patients.

T. Azzopardi and et al in their study observed that functional outcomes were not significant in K wire as compared with closed reduction and casting group. Anatomically supplementary fixation by K wire was only marginally superior to cast immobilization alone in reducing displacement of the fracture after closed manipulation.

Restoration of normal anatomy is crucial for restoration of function. Normally 82% of the compressive load at wrist joint is borne by distal radius and remaining by distal ulna. 2.5 mm loss in radial length results in 42% load on ulna and with 20 degree of dorsal angulation, ulna bears 50% of load.

Restoration of radial length is the most important factor for preservation of function. Loss of radial length can lead to ulnar impaction or dysfunction of DRUJ, with limited range of motion in pronation and supination, depending on the volar or dorsal subluxation of the ulnar head within the sigmoid notch.

Radiocarpal articular congruity remains the most clinically significant radiographic parameter regarding both functional outcome and future degenerative changes. If 2 mm of incongruity were present, there was a 100% incidence of degenerative changes on plain x-rays.

Residual dorsal angulation can precipitate ulnar impaction, midcarpal instability and altered stress concentration which may lead to early arthritis. Gartland and Werley concluded that residual dorsal tilt has a more direct effect on outcome than residual radial deviation, radial shortening, or loss of integrity of the radioulnar joint. Porter, in his study, felt that loss of function did not occur until at least 20 degrees of palmar tilt was lost.

In both treatment methods radial length, ulnar varience, radial angulation are restored to near normal but correction of dorsal tilt is not complete. This is because the fact that volar ligaments are stronger on distraction before relatively 'Z' oriented dorsal ligaments. So, on distraction volar cortex is brought out to length before dorsal cortex preventing full correction of dorsal tilt.

Cast immobilization alone could not maintain reduction in unstable fractures resulting in poor anatomical outcome. 53 % patients of cast

immobilisation had moderate to severe deformity compared with only 11.76 % patients of K wire and casting group having moderate deformity.

CONCLUSION

Fractures of distal radius are common and appear simple, affect the function of wrist and hand considerably. It is most common fracture encountered in outpatient department. Majority of these fractures are unstable resulting in loss of reduction and hence malunion, poor range of motion and early arthritis, altered wrist kinematics and early arthritis. For better outcome of management the goals of treatment are

1. To achieve perfect anatomical reduction and maintain the reduction till union
2. Early mobilisation to achieve good range of movements and to prevent stiffness.
3. To prevent early and late complication

In unstable distal radius fractures both the techniques of managements K wire fixation and casting and closed reduction and casting gives near equal results in terms of functional outcome. Better anatomical reduction and maintenance of reduction can be expected with K wire fixation and casting group.

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APPENDIX I

DISABILITY OF ARM, SHOULDER AND HAND (DASH) SCORING TO EVALAUATE FUNCTIONAL OUTCOME

DISABILITIES OF THE ARM, SHOULDER AND HAND

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Write.	1	2	3	4	5
3. Turn a key.	1	2	3	4	5
4. Prepare a meal.	1	2	3	4	5
5. Push open a heavy door.	1	2	3	4	5
6. Place an object on a shelf above your head.	1	2	3	4	5
7. Do heavy household chores (e.g., wash walls, wash floors).	1	2	3	4	5
8. Garden or do yard work.	1	2	3	4	5
9. Make a bed.	1	2	3	4	5
10. Carry a shopping bag or briefcase.	1	2	3	4	5
11. Carry a heavy object (over 10 lbs).	1	2	3	4	5
12. Change a lightbulb overhead.	1	2	3	4	5
13. Wash or blow dry your hair.	1	2	3	4	5
14. Wash your back.	1	2	3	4	5
15. Put on a pullover sweater.	1	2	3	4	5
16. Use a knife to cut food.	1	2	3	4	5
17. Recreational activities which require little effort (e.g., cardplaying, knitting, etc.).	1	2	3	4	5
18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5
19. Recreational activities in which you move your arm freely (e.g., playing frisbee, badminton, etc.).	1	2	3	4	5
20. Manage transportation needs (getting from one place to another).	1	2	3	4	5
21. Sexual activities.	1	2	3	4	5

DISABILITIES OF THE ARM, SHOULDER AND HAND

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
22. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups? *(circle number)*	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? *(circle number)*	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. *(circle number)*

	NONE	MILD	MODERATE	SEVERE	EXTREME
24. Arm, shoulder or hand pain.	1	2	3	4	5
25. Arm, shoulder or hand pain when you performed any specific activity.	1	2	3	4	5
26. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5
27. Weakness in your arm, shoulder or hand.	1	2	3	4	5
28. Stiffness in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? *(circle number)*	1	2	3	4	5

	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem. *(circle number)*	1	2	3	4	5

DASH DISABILITY/SYMPTOM SCORE = $\left[\frac{(\text{sum of n responses})}{n} - 1\right] \times 25$, where n is equal to the number of completed responses.

A DASH score may <u>not</u> be calculated if there are greater than 3 missing items.

APPENDIX II

LINDSTROM AND FRYKMAN GRADING FOR ANANTOMICAL OUTCOME

DEFORMITY GRADE	DORSAL ANGULATION	RADIAL SHORTENING
GRADE I (No significant deformity)	Not exceeding neutral	< 3 mm
GRADE II (Mild deformity)	1-10°	3 - 6 mm
GRADE III (Moderate deformity)	11-14°	7 - 11 mm
GRADE IV (Severe deformity)	>14°	>11 mm

APPENDIX III

CONSENT FORM

சுய ஒப்புதல் படிவம்

மணிக்கட்டு எலும்பு முறிவிற்கு கம்பி பொருத்தி அறுவை சிகிச்சை செய்தவன் பலன்கள் மற்றும் விளைவுகள்

ஆராய்ச்சி நிலையம் : அரசு ஸ்டான் மருத்துவமனை
சென்னை - 600 001.

பங்கு பெறும் நோயாளியின் பெயர் :

வயது :

ஆண்/பெண் :

பங்கு பெறுபவரின் எண் :

கீழ்கண்ட வற்றில் பங்கு பெறுபவர் (✓)குறிக்கவும்

1. மேலே குறிப்பிடப்பட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு என்னுடைய தாய்மொழியில் விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டது. ☐

2. நான் இவ்வாய்வில் தன்னிச்சையாக பங்கேற்கிறேன். எந்த காரணத்தினாலும் எந்தக் கட்டத்திலும் எவ்விதச் சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகிக் கொள்ளலாம் என்பதை அறிந்து கொண்டேன். ☐

3. இந்த ஆய்வு சம்பந்தமாகவோ அல்லது இதை சார்ந்த மேலும் ஆய்வு மேற்கொள்ளும்போதோ இந்த ஆய்வில் பங்கு பெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவை இல்லை என அறிந்து கொள்கிறேன். ஆய்விருந்து நான் விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன். ☐

4. இந்த ஆய்வில் நான் பங்குபெற ஒப்புக் கொள்கிறேன். எனக்கு கொடுக்கப்பட்ட அறிவுரைகளின்படி நடந்து கொள்வதுடன் இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதி அளிக்கிறேன்.

5. என்னுடைய உடல் நிலை பாதிக்கப்பட்டாலோ அல்லது எதிர்பாராத வழக்கத்திற்கு மாறான நோய்குறி தென்பட்டாலோ உடனே அதனை மருத்துவ அணிக்கு தெரிவிப்பேன் என உறுதி அளிக்கிறேன். ☐

6. அறுவைசிகிச்சைக்கு முன்னரும், அறுவை சிகிச்சையின் போதும், அதற்கு பின்னரும் இரத்தப் பரிசோதனைகள், ஊடுகதிர்கள் (X-Ray) எடுக்கவும், மயக்கமருந்து கொடுத்து அறுவைசிகிச்சை மூலம் மணிக்கட்டு எலும்பு முறிவிற்கு கம்பி பொருத்தவும் சம்மதம் அளிக்கிறேன். ☐

7. என் நலன் கருதியே இந்த ஆய்வு மேற்கொள்ளப்படுகிறது என்று தெரிந்து இந்த ஆய்விற்கு ஒப்புதல் அளிக்கிறேன். ☐

நாள் :

இடம் :

பங்கேற்பவரின் கையொப்பம்
அல்லது
இடது கை பெருவிரல் ரேகை
(இந்த படிவம் படித்து காட்டப்பட்டு புரிந்து
கைரேகை அளிக்கின்றேன்)

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்

நோயாளி தகவல் படிவம்

மணிக்கட்டு எலும்பு முறிவிற்கு கம்பி பொருத்தி அறுவை சிகிச்சை செய்தவன் பலன்கள் மற்றும் விளைவுகள்

நோயாளிக்கான தகவல்கள்

ஆராய்ச்சியின் நோக்கமும் ஆதாரங்களும்

இந்த ஆய்வின் மூலம் மணிக்கட்டு எலும்பு முறிவிற்கு கம்பி பொருத்தி அறுவை சிகிச்சை செய்தவன் பலன்கள் மற்றும் விளைவுகள் கண்டறியப்படும்.

அளவீடுகள்

ஊடுகதிர் (X-Ray) படத்தில் அறுவை சிகிச்சைக்குப்பின் உடைந்த எலும்பு ஒன்றாக சேருதல்.

அறுவை சிகிச்சைக்குப்பின் எவ்வித உபகரணத்தின் உதவியுமின்றி குறுகிய காலத்தில் கை முழுமையாக குணமடைதல்.

ஆய்வு முறைகள்

அறுவை சிகிச்சை மூலம் கம்பி மூலம் எலும்பு முறிவை சரி செய்தல்.

ஆய்வில் உங்கள் உரிமைகள்

உங்கள் மருத்துவப் பதிவேடுகள் மிகவும் அந்தரங்கமாக வைத்துக் கொள்ளப்படும். இந்த ஆய்வின் முடிவுகள் அறிவியல் பத்திரிக்கையில் பிரசுரிக்கப்படும். ஆனால், பெயரை வெளியிடுவதன்மூலம் நீங்கள் அடையாளம் கண்டு கொள்ளப்படமாட்டீர்கள். இந்த ஆய்வில் உங்களது பங்கேற்பு தன்னிச்சையானது. மேலும், உங்களுக்கு விருப்பமில்லையெனில் காரணங்கள் எதையும் கூறாமலேயே இந்த ஆய்விருந்து எந்த நேரத்திலும் நீங்கள் விலகிக் கொள்ளலாம். இந்த ஆய்வினால் ஏதேனும் பக்க விளைவுகள் ஏற்படின் அதற்குரிய முழு சிகிச்சையும் மருத்துவக் குழுவினரால் அளிக்கப்படும்.

நோயாளியின் கையொப்பம்
அல்லது இடது கை பெருவிரல் ரேகை

நாள் :
இடம் :

APPENDIX IV

CLINICAL PROFORMA

1. Name

2. Age

3. Sex

4. In-Patient no.

5. Mode of injury

6. Side of injury

7. Dominant side

8. Occupation

9. Address and contact no.

10. AO type

11. Associated injury

12. Associated complications

13. Date of injury

14. Date of surgery / plaster immobilization

15. Date of K Wires / plaster removal

16. Preoperative radiology

    Radial length –

    Volar tilt –

    Radial angulation -

Ulnar variance –

Dorsal comminution –

15. Post operative radiology

Radial length –

Volar tilt –

Radial angulation -

Ulnar variance –

16. Pin site infection

NINE WEEKS:

17. Stiffness

18. Pain

19. Functional status

20. Median nerve deficit

21. Radial sensory nerve deficit

22. Tendonopathy

23. Range of movements

MOVEMENT	ROM
Palmar flexion	
Dorsiflexion	
Radial deviation	
Ulnar deviation	
Supination	
Pronation	

24. Radiological parameters

	FINDINGS	DIFFERENCE FROM NORMAL
Radial length		
Volar tilt		
Radial deviation		
Ulnar deviation		

25. Grip strength - (% 0f opposite side)

26. DASH Score

27. Lyndstrom & frykman grading

TWELVE WEEKS:

28. Stiffness

29. Pain

30. Functional status

31. Median nerve deficit

32. Radial sensory nerve deficit

33. Tendonopathy

34. Range of movements

MOVEMENT	ROM
Palmar flexion	
Dorsiflexion	
Radial deviation	
Ulnar deviation	
Supination	
Pronation	

35. Radiological parameters

	FINDINGS	DIFFERENCE FROM NORMAL
Radial length		
Volar tilt		
Radial deviation		
Ulnar deviation		

36. Grip strength - (% 0f opposite side)

37. DASH Score

38. Lyndstrom & frykman grading

APPENDIX V

Key to Master Chart

Sex : M - Male

F - Female

Side of injury: R - Right

L – Left

A O – Arbeitsgemeinschaft für Osteosynthesefragen

K wire - Kirschner wire

RL - Radial length

VT - Volar tilt

RA - Radial angulation

UV - Ulnar variance

DC - Dorsal comminution

complicn - Complication

Pi - Pin site infection

Ts - Tendonopathy

Pain N - Nil

M - Mild

md - Moderate

Fn status - Functional status

W - Working
R - Restricted work

U - Unable to work

PF - Palmar flexion

DF - Dorsi flexion

RD - Radial deviation

UD - Ulnar deviation

SP - Supination

PR - Pronation

GS % of N - Grip strength percent of normal

Df fr N - Difference from Normal

DASH score – Disability of Arm, Shoulder & Hand score

L & F grade - Lindstrom and Frykman grade

MASTER CHART – K WIRE FIXATION AND CASTING

Sl.No.	Name	Age (In yrs)	Sex	Side of injury	AO type	Preoperative					Postoperative				Complication	Pain	En. Status	Stiffness	OUTCOME											DASH Score		L & F Grading
						RL	VT	RA	UV	DC	RL	VT	RA	UV					Range Of Movements in degrees						Diff fr N				GS	% Of N	9 wk	12 wk	
																			PE	DE	RD	UD	SP	PR	RL	VT	RA	UV				
1	BS	37	F	R	A2	6	-20	17	-3	-	11	15	20	-1	-	N	W	-	86	79	30	30	78	81	1	5	4	2	88	35.8	13.3	I
2	BB	45	M	R	A3	5	-22	15	-1	+	10	8	21	+1	-	N	W		70	72	29	29	72	80	4	12	4	1	75	41.4	22.4	II
3	DV	60	F	L	A3	4	-25	14	−2	+	9	10	15	+2	-	N	W	-	83	76	15	29	78	79	2	7	2	0	88	41.1	15.5	I
4	FR	48	F	L	A3	6	-22	15	−1	+	10	5	18	+1	Pi	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	....	..
5	FB	49	F	L	A2	5	-22	12	-1	-	9	5	15	-1	-	N	W	−	81	80	25	30	60	80	3	13	5	2	92	34.5	17.2	II
6	GH	42	M	R	A3	4	-22	16	-1	-	9	10	18	+1	Pi	N	W	-	86	79	21	32	77	81	1	8	4	0	96	41.4	15.5	I
7	JK	58	M	L	A3	5	-20	12	−3	+	10	5	17	+1	-	N	W	−	83	76	27	32	79	83	3	13	5	0	87	31	12.1	II
8	KT	52	M	R	A2	6	-25	10	−2	-	11	8	22	-1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	....	..
9	KS	59	F	L	A3	-3	-20	11	0	+	12	22	20	0	Pa	M	R	−	56	60	15	20	60	59	5	10	4	1	74	56	37.1	II
10	LS	47	M	L	C1	5	-26	10	−1	+	12	24	23	+1	-	N	W	-	86	79	27	32	79	83	4	12	4	1	89	31.9	10.3	II
11	MS	55	M	L	A3	7	-20	16	−4	+	11	-5	25	+1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	....	..
12	MG	62	M	R	A2	8	-30	12	0	-	12	10	18	+1	Ts	M	U		59	60	9	17	40	40	8	15	7	1	50	63.5	39.3	III
13	PM	45	F	L	A3	-2	-25	8	-2	+	9	5	12	-1	Pa	M	R	−	60	59	15	26	58	60	3	12	4	2	75	55.8	30.8	II
14	PB	55	M	R	C1	-3	-30	-10	−3	-	8	5	20	0	-	N	W	-	79	70	19	30	70	79	3	13	3	0	90	56.3	27.7	II
15	ST	59	F	R	A2	-1	-15	-5	−4	+	7	10	15	+2	Ts	N	W	−	55	59	9	20	60	60	7	15	6	1	75	58.6	30.2	III
16	SU	60	F	L	A3	6	-25	22	3	-	15	4	25	+1	Ts	N	W	-	74	72	15	29	55	79	4	10	5	0	87	47.4	20.7	II
17	SR	28	M	L	A3	5	-25	15	-1	+	16	25	24	-2	-	N	W	-	87	86	27	35	87	88	1	9	5	2	99	30.2	11.2	I
18	VL	55	F	R	A2	5	-20	8	2	+	8	10	15	+1	-	N	W	-	81	77	24	28	85	80	2	5	4	0	90	50.9	27.6	I
19	RB	65	F	L	A3	6	-30	10	−3	-	12	-9	25	0	-	M	R	−	63	60	15	20	40	58	5	14	3	1	50	54.5	31.9	II
20	TA	50	F	L	A3	8	-22	12	2	+	13	10	15	+1	-	N	W	-	80	77	24	30	76	79	4	10	4	0	90	40	23.8	II

MASTER CHART – CAST IMMOBILIZATION

Sl.No.	Name	Age (In yrs)	Sex	Side of injury	AO type	PreReduction					PostReduction				Complcn	Pain	En. Status	Stiffness	OUTCOME											DASH Score		L & F Grading
						RL	VT	RA	UV	DC	RL	VT	RA	UV					Range Of Movements In Degrees						Diff fr N					9 wk	12 wk	
																			PF	DF	RD	UD	SP	PR	RL	VT	RA	UV				
1	AD	38	F	L	A2	5	-22	10	+2	-	6	-5	22	+1	-	N	W	+	60	72	21	24	60	79	7	30	2	1	65	50.9	29.3	III
2	AB	55	M	L	A3	7	-20	16	+2	-	9	10	25	+2	-	M	W	+	72	74	20	29	68	60	3	23	1	1	75	44.6	17.9	II
3	AD	50	F	R	A2	5	-30	14	13	+	10	7	20	11	-	M	R	-	68	77	19	30	68	81	3	24	2	0	85	56	29.3	II
4	BK	60	M	L	A3	5	-30	12	+4	-	8	0	22	+1	Ts	Md	R	+	47	54	15	18	40	60	12	30	5	2	50	58.9	34.8	IV
5	DL	37	M	R	A3	1	-25	9	+3	+	10	10	15	+1	-	N	W	-	77	88	20	27	77	83	1	12	7	0	80	43.1	17.2	I
6	DJ	32	F	R	C1	6	-22	15	+1	-	11	6	20	0	-	N	W	+	72	73	18	30	68	86	3	23	4	1	90	42.2	17.2	II
7	DS	45	M	L	A2	7	-18	10	+2	+	14	10	22	+1	-	N	W	-	70	76	16	32	79	87	0	12	0	1	60	27.6	10.8	I
8	IZ	47	M	L	A3	-2	-32	-8	+4	+	10	0	20	+1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	....	..
9	IR	48	F	R	A2	-2	-22	-5	+4	-	7	-7	15	+2	Ts	Md	U	+	40	50	10	15	38	40	5	36	5	1	60	47.4	25	IV
10	KT	57	F	R	A3	5	-25	14	+1	+	12	7	20	+1	-	N	W	-	78	81	17	30	62	81	3	20	5	2	90	45.8	20.8	II
11	ML	50	F	L	A3	-2	-14	-5	11	-	11	0	20	0	-	N	W	1	70	72	17	32	59	81	7	31	5	1	70	33.6	11.2	III
12	MS	62	M	R	A2	5	-25	17	+2	+	7	-5	17	+2	-	M	R	+	50	59	15	29	60	81	5	33	5	0	75	58	39.4	III
13	PT	57	F	L	A3	6	-21	15	+2	-	8	10	20	+2		N	W	-	60	77	15	30	72	60	3	10	3	0	80	40.5	14.7	II
14	PM	49	F	R	A3	6	-24	18	+2	+	12	7	23	+1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	....	..
15	RD	60	F	R	A2	5	-30	10	+2	-	7	-6	22	0	Ts	Md	U	+	54	50	15	17	70	55	0	36	2	1	50	61.6	39.8	IV
16	RS	49	M	L	A3	6	-20	16	0	-	11	6	18	+1	-	N	W	-	72	77	18	32	86	89	3	23	5	0	80	31.3	11.6	II
17	RN	60	F	R	A3	3	-22	8	+4	+	8	-4	15	+1	-	M	R	-	68	59	14	31	60	79	7	33	6	1	80	62.9	37.9	III
18	SJ	53	M	L	A2	5	-23	12	0	+	9	-5	16	+1	-	N	W	-	77	77	18	32	60	86	6	31	5	0	75	33	10.7	III
19	SR	59	F	L	A3	0	-24	8	+3	1	12	8	20	+1	-	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	....	..
20	SL	60	F	L	A2	3	-20	8	+3	+	6	0	22	+2	Ts	Md	R	+	60	60	16	20	40	59	6	33	2	1	65	56	30.2	III

INSTITUTIONAL ETHICAL COMMITTEE
STANLEY MEDICAL COLLEGE CHENNAI-1

Title of the work : Analysis of functional outcome for distal radius fractures treated with closed reduction and percutaneous 'K' wire fixation with casting and closed reduction with casting : A comparative study.

Principal Investigator: Dr. Suryawanshi Vikram Vilas

Designation : PG in MS (Ortho)

Department : Department of Orthopaedics
Government Stanley Medical College,
Chennai-1

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 08.07.2013 at council hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The principal investigator and their team are directed to adhere to the guidelines given below:

1. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
2. You should not deviate from the area of the work for which you applied for ethical clearance.
3. You should inform the IEC immediately, in case of any adverse events or serious adverse reaction.
4. You should abide to the rules and regulations of the institution(s).
5. You should complete the work within the specified period and if any extension of time is required, you should apply for permission again and do the work.
6. You should submit the summary of work to the ethical committee on completion of the work.

16/7/13

MEMBER SECRETARY,
IEC, SMC, CHENNAI